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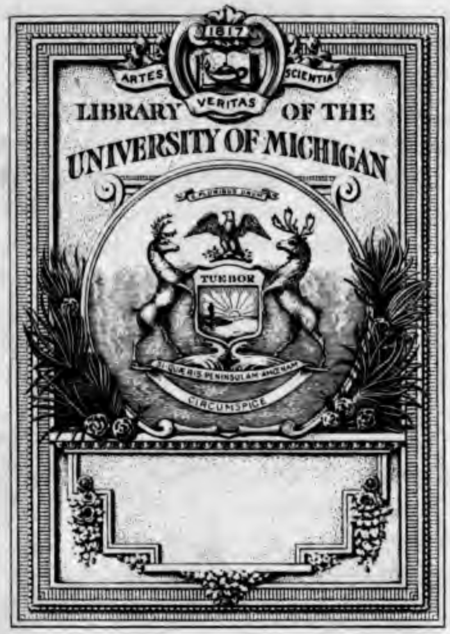
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FLORIDA

Geological [illegible]

STATE GEOLOGICAL SURVEY,

1887.

By J. KOST, M.D., LL.D.

TALLAHASSEE, FLA.:
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FIRST REPORT

OF THE

GEOLOGICAL SURVEY OF FLORIDA,

BY J. KOST, M.D., LL.D.

To His Excellency, E. A. Perry, Governor of the State of Florida.

SIR: I have the honor to report that I proceeded immediately to the work of the State Geological Survey, after receiving my commission, and that I have improved all my time in the work of the survey that my other professional duties admitted.

I am pleased, sir, to be able to report some material success, even while the conveniences for my work were limited. But as nothing more at present has been expected to be done other than a preliminary inspection, and such general geological observations as were possible under the circumstances recognized in the giving of the commission, I have not attempted *thorough* work in any part of my proceedings.

I am ready now to state that the results of my observations will fully justify the Legislature this spring to provide for a two year's work in a regular geological survey of the State by the services of a State geologist and assistant, with the help of a civil engineer, who can also serve as draughtsman, and a competent chemist, who may also serve as naturalist. This would comprise a corps of four men. This personal help, with some provision for contingent expenses, as means for transportation and the employment of two common laborers, will effect all required for the time here specified.

These suggestions, I think, are warranted by the facts now to follow in this report.

Aware of the fact that the State had never received attention in the way of a geological survey, and that no casual or transient attention ever made could afford a basis for procedure, I determined first to ascertain the horizons of the bed rocks in the tertiary of the State, their dip, thickness and character. This effected would then admit of the adoption of a plan of regular special geological local work in the usual way successively.

In the first named particular I found, as I had expected it, that no inconsiderable difficulty had to be encountered from the presence, almost everywhere, of deep deposits of the quarternary and recent materials, as sand, clays and humus. Very few exposures of bed rock were discoverable. On the other hand the cuts for roads and excavations for other improvements are so inconsiderable in this level country that the facilities thus to be afforded are very meagre. Nor are the exposures of river excavations and coast erosions of any greater advantage.

From these considerations I soon became impressed with the fact that the means at hand in this preliminary work will not afford the accomplishment of the proposed primary object, that is a full determination as to the character of the tertiary rock beds in all parts of the State, in reference to their thickness, dip and horizon. Nevertheless, some progress has been effected in these regards. I have discovered that every member of the tertiaries is present, and that the deposits are of considerable depth, especially of the lower or *eocene.*

I predicted at an early part of my inspection that a pretty extensive anticlinal, of an axis parallel with that of the peninsula, trends centrally through the peninsula.

I was led to believe that the force that effected the uplift was exerted soon after the deposit of the eocene, because the later rocks differ in character on the two sides of the ridge. Those of the east are coquina rocks, while those of the west are coraliferous and shelly limestone and sandstone, with much silicious material. Now, therefore, the physical conditions in which these several deposits were made were essentially different.

There is pretty good evidence also that the southern portion of the peninsula, for some time, had lain at a higher altitude than as at present; and also higher than portions of more northern parts of the peninsula. I do not take the northward flow of the waters of the St. Johns, Withlacoochee, upper part of the Ocklawaha, and part of the tributaries of the Santa Fe, as the only evidence of this presumption.

Middle and Western Florida have in their bed-rocks the same characteristics as those of the west slope or half of the peninsula. The superimposed materials are remarkable for their depth, and the presence of clays and loose sandstone and soft limestone.

In most parts of the State all the rocks later than the eocene, and this latter itself, often are exceedingly cavernous, admitting of vast channels, and running streams, into which very numerous sinks descend abruptly. These are of all dimensions, from a foot or more in width to extent of several acres of surface. These, indiscriminately, are liable to be of the same depth—that is they are all liable to be quite deep. When these have water present, this may be continuous with the common water level. But when the sinks are choked up by descent of waterfalls, the water will steadily hold a somewhat normal depth or level. The water of the deep ones often tallies with the tide of the sea, showing that the opening is continuous.

In nurmerous instances these subterranean streams open out in springs, some of which are of immense size and force. These springs have various distances as to source. Some of them come from sinks draining contiguous surfaces, and thus bring up leaves and woody fragments, various in size and freshness. Leaves are sometimes brought up in the larger springs, that are quite fresh and green. Fishes and insects are also thus ejected.

The waters of these springs are very diverse, according to the rocky materials which they traverse. A great number of them contain iron in form of a white hydrate; or on the other hand, in various degrees of oxydation, and so are more or less colored in various shades of redness. The iron comes from a sulphate or impure sulphuret, and thus of somewhat easy solution in the water. Some of the springs contain sulphurated hydrogen gas and are scented thus at a considerable distance. Lime, alumina, magnesia, soda and potash are very frequently present in solution. The gas in the water will escape on keeping, and persons are often surprised to find that their "*sulphur water*" ceases to be "*sulphur water*" when it is not fresh.

Iron is very widely distributed in small quantity throughout the clayey deposits, and in a smaller quantity but greater extent, in the sand deposit and rocks both of limestone and sandstone. The iron is mostly in solution but often in grains, nodules and boulders. Always in a carbonated oxide, more or less phosphatic.

Lime is as widely distributed, and exists also in solution, and in silt and rocks. But of these—special economical deposits—I must, later on, speak more particularly.

GEOLOGICAL PRINCIPLES.

It seems almost absurd that on so slight an inspection as has yet been made, that any statements should be ventured upon concerning the principles ot the geological formation of our State. But as what concerns these will aid in accounting for other facts that must come into this report, I shall, nevertheless, proceed to state some obvious facts concerning the physical history of our portion of this continent.

When the lower beds or eocene rocks were in course of deposit the territory of our State was reposing at the bottom of the sea, at a depth of from one hundred to several hundred feet, and was, for a time, sinking slowly; that is, at a pace correspondent to the continuous building of coral reefs. This depth is indicated by the character of the fossils imbedded in the rocks and by the lithological character of the rocks themselves.

This assumes, what is commonly admitted by geologists, that the limestone deposits are made in the deeper seas, and sandstone in more shallow seas.

This older tertiary deposit, though new geologically, is yet, when judged of in secular history, very *old*, because it dates back to the time anterior to the upheaval of the lower half of the Rocky Mountains.

In course of geological time the oscillation changed, and the bottom of the sea began to rise. I need not advert here to the geological principles occasioning these changes of level or physical modifications which are universally admitted and adverted to for accounting for the facts of nature. But an uplift was in progress, which was, at first, moderately slow. During this period there occurred the deposit, now denominated the oligocene; and the fossils in this formation differ somewhat from those below, in that, that they possess various newer types.

In still later geological time the bottom of the sea was near the surface and in many places dry land appeared. At this epoch the miocene or middle tertiary was laid down. This was of a most remarkable character and brings forward in our State a geological characteristic that is somewhat peculiar, though not very dissimilar to the lacustrine tertiaries in Nebraska and other parts of the eastern slope of the Rockies.

At this time the land lay, for a protracted period, at or near the level of the sea. There were both salt and fresh water bays, estuaries and inland lakes. Among these were swells of land, stretching along in somewhat extended distances and varied width, that were overgrown with vegetation, comprising reeds, grasses, shrubbery, trees and vines. These were various in density or profusion and were in some localities in dense thickets.

Over these stretches and among these thickets there were populations of a vast variety of animals, comprising insects, winged and crawling; reptiles, birds and quadrupeds; as also, from some proofs, a species of bimania. Huge monsters of the sea coasted along the borders of the waters. These were the zeuglodon, a whale of an immense size, much larger than whales get to be now. Also the carcharodon, a species of shark as large as the largest of whales now living. These have left remains of teeth as large as a man's hand.

But these are only the chief or princes of the denizens of these coasts. Fishes and reptiles teemed by the million in all the waters everywhere, gliding and crawling about tangles of seaweeds, clusters of gorgonias and cliffs of corals, while the bottoms, sandy or muddy, were all overstrewn with moluska, crustacea, stellata and echinoidea of all colors and shapes.

On the borders of these waters of bays and rivers there grazed a unique monster, semi-reptile fish, allied to the present manatee, but vastly larger, and which existed in immense herds. In a great bay that extended up northward, between the Ocklockonee and Sopchoppy rivers, these monsters, as also another coaster, the charcharodon, existed in amazing numbers, so that now there are depths of phosphate deposits there exceedingly rich in phosphoric acids, all afforded by marine and amphibian animals. In these deposits their fossil bones lie imbedded in great numbers. But the times were turbulent, as these bones are broken into fragments, there seldom being pieces of more than two or three pounds weight.

In Alachua county, especially in the south part thereof, there was a rich savanna, herded by the rhinoceros, mastodon, camel, horse, ox, llama and goat. Among these were harboring in the tangles of chapparal, cactus, palms and divers vines, a fierce species of the lion, and a variety of leopard, tiger and hyena, that were ever watching for their prey among the smaller of the landed animals. A very large bear also was common. Dr. Neal, of Archer, was one of the first to cite attention to these fossils. He has sent to the National Museum at Washington a considerable variety of them.

In Taylor county a large order of elephant was existing. One skeleton, in the possession of Dr. Wilcox, at Perry, is in a state of some completeness. But this American elephant existed also elsewhere in Florida, though not so abundantly as the mastodon. The manatee, zeuglodon and a vast variety of sharks have left their remains by the hundreds of tons, and in some localities considerable sections of rocks consist of these remains almost exclusively. But there were also an infinite number of other kinds of animals during the time of this formation whose remains would not find burial in the water and so would perish and fail to appear at present.

PHYSICAL GEOGRAPHY.

The physical geography of this period was one which affords much interest to the geologist. The bays and lakes were much more numerous in the middle tertiary age than as now. These were of various depths. Some were *quite deep*, others *shallow*, and widely extended, as Lake Okeechobee is now. The deep ones, when opening to the sea, were always abounding with the larger fishes, as the sharks, whales, rays and the manatee. But the sharks were most abundant. The shallow bays teemed with oysters, clams and other shell fish, and were populated by birds in large numbers, but their remains being more perishable, are less frequently found. The reptiles, as alligator, turtle and serpents abounded also.

It is evident that the waves from the sea encroached upon the shallow savannas frequently, else the remains of the land animals could not have been preserved, except as thus swept into the sea or buried in the marshes.

Rains were very frequent during the miocene age, and storms were furious ; and these incidents can alone explain the almost universally broken state of the fossils we find.

In the after age, when the pliocene and quarternary times came in, there was a submergence of the land once again. This is proven, not only by the character of the fossils, but the deposit of the vast amount of clay and sand so extensively over all the lower beds. These were not successive wave deposits upon a retiring shore, for such characteristics are not thus impressed; nor could these great clay deposits be thrown ashore from the depths of the sea in a manner so clean and distinct. Not only was *Florida* again engulfed by the sea, but Alabama, Mississippi, Louisiana and sections of Tennessee, Arkansas and Texas.

The gulf stream then passed over much of these submerged lands, and cut away from sections, westward, which had existed as swells or hills. Thus our Florida clay came from ridges in lower Alabama, thus cut away and carried by the gulf stream through the Florida sea or northern portion of the gulf, then extending into lower Georgia.

Our iron, clay and much of our sand is from Alabama, where the carboniferous beds were cut away and gave us their clays, iron and sand, as also various other minerals that are found here.

Only one other theory, and the facts of which come into the bounds of probability, can readily account for the clay, iron, &c., which we have. This theory contemplates what seems almost an absolute geographical necessity. It is, that a broad belt connecting North and South America, from Florida to New Grenada, through the range of the Antilles and Carribean Isles, formerly existed. This seems evidently to have been wider than that now existing through Central America, making the continental continuation. When this belt or continental section was disintegrated by the trade currents that now in continuation constitute our gulf stream, then our clays and pliocene material may have had their derivation from thence. Surely all this material was not brought down from Georgia, as the physical facts all disprove it, and this with a unanimity of evidence that makes it seemingly a law.

Following the inquiry concerning the prevalent physical geography of Florida, I may make adversion to the cause of the hills and valleys of our State; and while such questions, as already stated, may seem to be too premature, owing to the incipiency of the survey, it is, as in the co-ordinate case, also of use in explanation of other necessary facts. Still an exhaustive disquisition is by no means possible now. The question must be settled as to the facts of upheaval on the one hand, and those of erosion on the other, before a satisfactory thesis can be afforded.

We discover that the bed rocks of Florida were not only lifted, in all parts, from the depths of the sea, but we know almost equally well that the uplift was not an *even* or *simple* one. It consisted, not of a secular rise, but of paroxysmal phenomena, such as have *tilted* rocks as they are now found to be, and which have lifted rock beds into respectable altitudes. On a hill just west of the college building at Tallahassee are strata uplifted and tilted even into vertical positions. These strata have alternations of flint rocks, sandstone and limestone; and these are interstratified by clays. Similar facts are found elsewhere also. Hence those who are disposed to rob our State of the element of *variety* in its physical geography and geological characteristics, had better finish their sayings before the geological survey of this State is published.

The element of *erosion* comes in with a strong claim for recognition; and the attention of the survey will be properly directed in this regard. The idea of the scooping out of the valleys and the leaving of the hills is not attempted to be overlooked in the report of this preliminary work. Here, as elsewhere, both these causes of brokenness of the country have had their co-ordinate share of causation.

A proportionately large portion of the State is flat and sandy, without presence of rocks at surface. The other and smaller portion is undulating and even hilly in some sections. These latter are found along the water courses, even as is the case in the older geological formations. I shall not attempt here to specialize these water courses and more broken portions of land, but will state that they are common to all parts of the State and are notably in accord with the sizes of the streams. Still, while this statement is ventured, I must again mention the fact that I have not had the *time* necessary for a good physiographic inspection.

I may report the country of Florida as well *watered* with both flowing and pure streams and magnificent lakes. Many of the streams have their water stained by precipitated foliage of the forests; but this discoloring does not occasion the presence of any unwholesome properties as affecting man or beast. It is simply the diffusion of the chlorophyla or coloring matter of vegetation and is devoid of any deleterious properties.

Streams, especially those fresh from springs, are apt to contain mineral matter, as lime, iron, alumina, silica, soda, magnesia (sparingly) and potash. In the general these waters are fresh, cool and agreeable to the taste, seldom other than strictly healthful. But in this regard it must be remembered that the waters of Florida, like those of all other countries, are liable to occasion disturbance of digestion by incident of change of *habit.* Persons and animals accustomed to any given variety of water, when changing from it to another of different character, will find, for a little while, some inconvenience, until the secreting organs of the body can adapt themselves to the change.

The waters of wells and springs of superficial sources are greatly more apt to be different and variable in properties. This is largely owing to the fact that the immediate sources of the waters are generally from the upper member of the eocene and the oligocene rock ("*rotten* limestone"), a very loose arenaceous limestone that contains a large proportion of fossilized organic remains. The presence of this is in part the occasion of the easy disintegration of the rock. Now, as the water reposes in and percolates through this soft rock, it must necessarily take into solution such soluble matters as are afforded by this rock material. Hence the water of the wells and springs in such districts as mark the approaches of this rock to the surface or near thereto is less wholesome than others. But Florida is by no means more afflicted with this order of things than many other countries. It does not, indeed, require the presence of upper tertiary rocks for the appearance of this characteristic. But all lands that have quarternary deposits and lacustrine and fluviatile bottom lands have the same liability, because these always, also, are liable to have the organic remains in deposit, and thus have their waters contaminated.

Persons may become accustomed to the use of such waters, and have comparative immunity. But the adaptation is more difficult than it is to specialties in the wells, springs, streams and lakes of other districts than those last above described. On the whole, the drinking waters of Florida are good and wholesome, and compare well with the waters of other level countries.

SOILS AND TIMBERS.

In regard to soils and timbers, the statement must be reiterated that the provisions for this preliminary survey have not afforded the facilities for the securing of all the information desired. The time has been too short, and the facilities for analysis of soils too meagre to have made it possible to accomplish much.

The soil, which is the main source of wealth, and the support of life, must assuredly be the object of chief concern in the geological survey. Nor is the suggestion that experience in husbandry is the surest means of knowing the resources and capability of the soil, of any significant weight against the purpose of a most thorough geological survey, for this, in the first place, is only a co-ordinate means of knowledge, that is, it can only do its *proportionate part*. On the other hand, the matter of time and opportunity for full investigation is one that makes geological researches of paramount character. *One year* of geological inspection will, in many essential particulars, do more than a century of farming operations.

One might as well argue for dependence on the continued use of *stone implements* instead of the availment of science in the achievement of possible uses of iron and the tempering of steel for *edge-tools.*

At this very day, on the fertile valleys of the Nile, where the lands have been in cultivation, *successively*, for four thousand years or more, the farmers still (in large extent) are in the primitive habits of soil culture, in the use of a forked stick as a plow, and the rudest means of reaping. But even in this proof of the slowness of improvement by the avails of the toils of the field, the Nile valley gives less than a tithe of the full comparison of what modern science affords in the case. The Nile, by its annual overflow, kept the soil in a state of fertility, and all that was needed was the knowledge of tilling it. But how is it where the lands are liable to become exhausted of their fertility? Experience in farming has subjected such lands to abandonment for years and for ages! How is it thus in vast tracts in Asia, and even in Europe, in this regard? Would it be unseemly if I should come *nearer home for citation* in these particulars?

Experience in common farming has not, in all the ages of husbandry, brought the tiller of the soil to the means of knowing *by the appearance of the soil*, and that of the growing of the plant, what there is lacking when the crops are not satisfactory. One farmer says: "I don't know what ails my ground, for it fails to produce; it looks dark and rich, but my crop is not worth gathering." Another says: "I took great pains to prepare my soil and sowed my best seed, in proper time; but, alas, I have no crop." Farmers have thus sold their plantations and moved away to other localities, in despair of ever extorting a complementary response, at home, and projected their hopes to new localities.

Now in all these cases, by the interposition of the avails of modern science, there may be a detection of even, some times, but an *insignificant* lack in the barren soils; possibly only a little potash, or phosporic acid, which may be supplied at a very trifling expense.

Much of the soil in Florida is quite fertile in the natural state; and a vast portion of soils that are not rich can be easily improved. I shall, further on in the report, advert to the means of this improvement. Some soils of pine lands are poor; and I am constrained to the discussion of the *cause* of this poverty, which also may best be done later on. But I demur to the habit of berating the State of Florida for the poverty of its soil; and I here, therefore, bespeak attention to what I will have to state as to *causes* of serious damage to lands where the blame attaches *entirely to the recklessness of the people!*

Fortunately for Florida, as will appear even in this hasty preliminary survey, the poorest lands in the State have their remedy close at hand; and it is a matter of great congratulation that we are near the day when our State shall no longer be slandered by sinister animadversions regarding its "*poor soil!*"

The following are common designations of the Florida lands: *First*, *second* and *third* qualities of pine lands, and *low* and *high hammock lands.* These vary in character and productiveness somewhat, each. The poorest or third quality of pine land consists almost bodily of fine white sand of pure silica, having only from 5 to 7 per cent. of other minerals, as alumina, lime, (this analysis I had reported in my article for the trade edition of the Jacksonville *Times-Union*, 1886; but more extended observations made by me since that time brings me to a report now of a larger per cent. of lime in the sand of the pine lands,) humus, soda, potash, magnesia and iron. The second quality is like it, but contains from 8 to 12 per cent. aggregate of the above addition to the sand. First quality of pine land has a composition about as follows: Silica, (sand) 80; humus, 8; lime, 4; alumina, 3; potash, 1; soda, 1; magnesia, 0.50; iron, 1.50; manganese, 0.30; phosphoric acid, 0.30; sulphuric acid, 0.50, This statement comprises the soil and subsoil of a mixture taken from three localities of first-class pine land in different parts of the State.

High hammock land, (clay land) comprising soil and subsoil, affords an average as follows: Loam, consisting of equal parts of sand and clay, 70; humus, 20; and with these somewhat similar proportions of lime, potash, soda, magnesia, phosphoric and sulphuric acids as is possessed by first quality of pine land, but this has more iron and some manganese.

Low hammock land varies considerably, according to presence of drainage or of marsh. The statement I give here takes in only the black deposit, which consists mostly of humus, shell and sand. The proportions of these differ. Some varieties consist mainly of muck, others have sand, and often a prevalence of marl. In low hammocks this latter is very common where streams are near.

Before leaving the matter of the analysis of the soils I must advert to a fact worth a reference. The sand deposits of Florida lands are very generally misjudged. They are generally estimated by the tourist by what he has been conversant with in deposits of "sand banks" in northern localities, distant from the sea, which are generally wind drifts or drifts from fresh water bays or lakes, and the sand is quite liable to be clean and free from earthy or saline admixture. But here in Florida the sand accumulations are from salt water bays or sea coasts, and they are never free from marine salts, or more especially having the presence of the dust of marine shells, in form of carbonate of lime from organic forms or shells of molusca. Hence the sands of Florida are far more productive as compared to others that are not of recent marine derivation. It happens, therefore, that tourists who have opportunity to inspect growing crops on the "*sandy barrens*," are not a little astonished to see respectably good crops grown on such lands. Similar sand deposits elsewhere—that is in the adverse circumstances—commonly are found to be almost completely barren.

ADAPTATION OF SOIL.

Climate has much to do in matter of adaptation of soils. Thus the same constituent chemical or mechanical characters of soils are yet quite varied in their adaptability for the different products they are capable of affording, just according as the climate may favor or disfavor such productions. Timothy and clover will grow luxuriantly in more northern localities, while here in Florida they do not grow well, and this is so even if the soil in the two localities is the same in character. On the other hand maize and tobacco do better on the same kind of soil here than these do in northern localities. Hence, taking these brief illustrations, as suggestive, we have grounds to justify the proposition that much is to be gained by the study of the adaptability of soils, as corelated to climate.

Perennial plants need a resting season to correspond to their perennial habit, and need alternations of temperature as winter and summer to make the deciduous habit complete, and thus to give the bud a good chance for its development. Perennial grasses need the resting of their stalks of seasons to enable the stooling out of their radicals, as in the case of timothy and clover. Hence in the long seasons of warmth, as in Florida, clover and timothy are prompted to habits of *annuals*, and hence they do less well here. But now comes the other side. The sparse extent of the *warmer* portion of the temperate zone gives Florida a monopoly that her citizens may well be glad of; and now since soils are not so particularly diverse, except in so far as the variation *favors* this section as in the tertiary soils, the assumption is pretty well put that the soils of Florida have *universal* adaptation—that is, they will grow everything the climate will favor.

Nevertheless, there are points that allow of special animadversion. Thus, the maize, comprising the corn family, and the cane, rice, tobacco, oats, cotton, ricinus, melons, &c., among such kinds, and the citrus family, fig, guava, peach, pomegranate, &c., among trees, have special adaptation, since while the soil is favorable, the *climate* eminently affords the conditions that insure the success, and prove the superior advantages in Florida over less favored localities.

Without attempting specialization in this report, intended to be brief, I will state that the soil of Florida will produce all sorts of vegetation that are grown elsewhere, and which the long warm seasons favor, and in addition, a great variety more, which the more rigorous climate of the colder portion of the temperate zone do not successfully produce.

Drainage has much effect on soils in regard to fertility. Excessive drainage is alike detrimental with deficient. Hence, localities where seeds in the ground and plants rooted therein, where water is resting continuously, will, in nearly all cases, be destructive of the seeds and plants, while excessive moisture in the earth, though not continuous, will still occasion much damage. On the other hand, it accords with general observation that soils which are leached by constant or continuous drainage, as in cases of mill dams, which when the attempt is made to recover the lands, will be found to be comparatively non-productive, however dark or good looking the soil may appear. Thus it is known that the bottom lands and flats that have standing water resting long upon them, and have displacements after they had been saturated by the strength of the soil, such soils are impoverished thereby. Many persons are surprised by the results of attempts at recovery of lands in such circumstances. On the other hand, lakes that are simple receptacles, and are little exposed to drainage, will leave a rich soil when recovered. Occasional overflows of river bottoms, as of the Nile and Mississippi, will also enrich the lands if the water only remains long enough to precipitate their silt.

These facts here enumerated explain much concerning the differences in the fertility of soils of *similar* appearance in Florida, where the lakes are so numerous and where tracts of lands are liable to occasional but brief overflows. Thus it happens that the black and dark colored soils of Florida are almost universally very fertile.

When the dark soils are not satisfactorily productive it is very probable that they will only need the application of potash, in the form of wood ashes, and phosphoric acid, in form of phosphate of lime. Stable manure is also very beneficial to such soils.

The sandy lands that lack productiveness need organic material in the form of vegetable composts, and even carbonate of lime, as marls, and of course, phosphate of lime will greatly help such lands.

I cannot take up space in this report to discuss the subject of timbers as indicating the qualities of soils, excepting only in a brief way.

Oaks and hickory timber generally indicate the presence of clay, even though this may not be readily detected at the surface. This kind of timber proves the soil to be good. Pine may grow on poor land but may also be found on those that are rich. When cypress trees stand in ground that has a clay bed near the surface of sufficient compactness to hold water, the roots of these trees will send up their characteristic "knees." These also appear where water held near to the surface by other causes, as by dams and high-water levels, the "knees" also are sent up. The roots require exposure to air as free at least as it is in soils out of water. Hence there is a criterion in cypress "knees" that determine habitual water levels. The gum grows only in rich soil to large extent, and though it tolerates the presence of water over its roots, yet it will not endure permanent submergence. The cabbage palmetto requires rich, moist sandy soil (prefers marl in the soil), but will not endure permanent submersion of its roots. The scrub palmetto will grow in the poorest sandy soil, and although it is found in rich lands also, yet its presence is no proof that the land is rich. Dogwood, cherry, walnut, magnolia, elm, linden, blue beech, spicewood, prickly ash, bay and sweet gum indicate rich soil.

I can not omit noticing in this report the incalculable mischief that is continuously done in vast sections of the

State, in the way of impoverishing the soil, by the annual firing of the woods. Those who either favor or tolerate the practice cannot have anything of a proper conception of the vastness of the damage thus done, or if they have they must surely have no regard for the best interests of the State, which interests are so certainly connected with the quality of the soil.

Forests tax the ground immensely, and in Florida *continuously.* In an ordinarily well timbered tract there is not less than two tons of fertilizing material taken from the ground to the acre, annually. When the woods are fired, by far the greater portion of this is driven off and permanently lost to the spot. It is not only the carbon of the materials which goes off in the smoke and vapors that are lost, but the salts, as of potash, &c., that remain in the ashes. These are brought into solution by the first rain which soaks them; and the running away of the water holding these materials in their solution carry off the potash, &c., with them. Before the spongioles and fibres of the roots of the trees had taken up these salts, they were greatly less free, and so undisturbed by the passage of water to a good extent. But now, when the action of the fire has freed them they will easily be taken away in solutions. How long will one suppose it will thus take until a rich soil will be *exhausted* of its *plant food* and be completely impoverished? And who is it that has not discovered that those woods that are annually fired have no soil; or if any, it is perhaps only from a half inch to one inch in thickness, it being simply the product of the last year's decayed vegetation, now in turn to be burnt up in connection with the last crop of leaves!

Nor is the impoverishment of the soil the only mischief thus done; for the trees—which by extra deep penetration of their roots may have maintained a feeble life—are destined, by the practice, to utter ruin. Before this happens the stumps or caudices are stooled out, and the dwarfed stems forced into lateral postures, which all know to be characteristic of the scrub woods in the "barrens."

I can but indulge the fondest hope that our Legislature will—in the very next session—put an effectual stop, by law, to the practice of firing the woods.

Mineral Deposits.

It has not been expected that the geological survey of Florida would eventuate in the discovery of the *precious metals*, or that great mines of the baser ones would reward the labor of the survey. Yet, it has been well judged that besides all that science—thus applied—would do for agriculture, horticulture and gardening in way of examination of the soils, there would be results in the discovery of important minerals for the industrial arts, in the finding of building stone, brick material, lime-rock, hydraulic cement, kaolin for fire brick, tile and pottery, silex for glass manufacture, pure carbonates for effervescence drafts, mineral springs, lignites, or coal, as well as other important substances. But the greatest expectation has been in the assurance that important fertilizers, in form of phosphates and marls, would be found, and these in great quantities.

Nature has ever afforded her bounties in *compensating* orders. In the far north, where the soil is sterile from the degrees of cold that exclude vegetation, there are deposits of the precious metals, as gold and silver, as also those still more useful, iron and copper. These make a full compensation in mineral wealth for all the lack of vegetation. The iron of Siberia, Norway and Lake Superior is the best in the world.

Now, should it be admitted that "Florida is largely a land of desolate barrens," then it might justly be given as a set-off that it has the richest of lands also, and the best climate on the continent, and withal deposits of mineral treasures of vast importance.

Phosphates.

Only a very little part of the labor of this preliminary survey could be given to the discovery of the large deposits of rich phosphates that are assuredly reposing in easy access within the State. But several localities have been found to have deposits of this material, quite as rich in phosphoric acid as are the phosphate rocks on Cooper and Ashley rivers in South Carolina.

No special attention has been purposed for the discovery of any particular deposits; but the abundance of evidence of phosphates of lime, phosphates of silica, phosphates of alumina, and phosphates of iron, especially, could not go unobserved. The wide distribution of that class of fossils, whose life-forms have evidently been the source of the phosphoric acid now constituting the phosphate rocks, namely, the sharks, whales and manatee occasioned a slight divergence of attention, and has led to some very important discoveries. Those, thus far, have been made in the counties of Wakulla, Alachua, Marion, Hillsborough and Manatee.

There are present in the phosphate stratum numerous fossils, comprising mostly finely preserved sharks' teeth, of the carcharodon species, and many of immense size, as of five inches length of each cutting edge. With these are vast numbers of the fragments of ribs mostly of the manatee. The manatee of the eocene age was also an animal of giant size, as the ribs are, some of them, two inches in thickness. This carcharodon must have attained the size of an hundred feet in length.

The locality in Wakulla county in which I have made the chief discovery, as yet, of phosphates is in the southwestern part, between the Sopchoppy and Ocklockonee rivers. In this locality the material is in a triple phosphate of lime, iron and alumina. When in rock mass this is a sandstone. Present in this are numerous fragments of fossil bones and teeth of sharks. The enamel of the latter is well preserved. The bones are petrified, and are in their acquired materials very similar to the material of the matrix in which they are imbedded. Where the fossils are abundant in a sand deposit, as is the case in various places, this sand is rich in phosphoric acid to a depth of stratum of 12 to 14 inches.

This sand was submitted by Prof. H. S. Greeno, of St. Louis, to Prof. A. Merrell, M. D., Consulting Chemist and Analyst, St. Louis, Mo., for qualitative analysis. In a letter from Merrell to Prof. Greeno, reporting the inspection of this sand, the following appears: "Gray sample, surrounding material, Sopchoppy (No. 2) Phosphate in abundance."

The following, received by Prof. Greeno also, giving results of inspection, has, in "No. 1," the sample of this sand bed of the bones:

REGIS CHAUVENET & BRO., Analytical Chemists,
709 Pine Street,
ST. LOUIS, MO., Jan. 13, 1887.

Dr. H. S. Greeno:

DEAR SIR: Samples of earthy phosphates, marked No. 1, Sopchoppy rock; No. 2, Ocklockonee rock, and No. 3, surrounding rock [matrix of fossils], left with us for qualitative analysis examination, show quite an amount of *phosphoric* acid, hence rich in phosphates. Sample No. 1 is very rich and we may say that it will analyze close to 20 per cent. in phosphoric acid. No. 2 will probably analyze 10 to 15 per cent. of phosphoric acid, while No. 3 will not come so high. On the whole the samples are quite rich enough for the market and merit a further examination. Respectfully,

REGIS CHAUVENET & BRO.

Of the above samples no one contained any of the fossil materials, but all consisted of the soft surrounding clay and sand, except No. 2, which was sand rock, taken from a spot remote from fossils.

The following letter is from Prof. J. M. Pickel, of the Florida State Agricultural College:

STATE AGRICULTURAL COLLEGE,
LAKE CITY, Fla., February 8, 1887.

Dr. J. Kost, State Geologist:

DEAR SIR: The Sopchoppy phosphatic rock which you left with me for analysis contains 23.85 per cent. of phosphoric acid (P 2, O 5), equivalent to 59.05 per cent. bone phosphate of lime (Ca 3, P 2, O 8). Very respectfully,

J. M. Pickel, Prof. of Chemistry.

P. S.—No bone was included in the sample analyzed.

J. M. Pickel.

In the analysis of Prof. Merrell, the sandstone deposit, in which stratum the fossil bones are imbedded, was pronounced by him as having "phosphate in abundance and closely allied to No. 2, gray sample" (sand).

The phosphates of the other localities in the State, where I have found them, are of the same character and richness as those of Wakulla county.

The great question now is: what is the extent of the deposits? As to this it has been quite out of my power to determine to any definite extent. But I do know that the distribution is through several townships in Wakulla county, and has a thickness of 12 to 14 inches and is resting in a depth of from 3 to 5 feet below the surface. It is not known, however, that the deposit is continuous throughout the localities where found, or whether only in patches. The investigation is as yet only commenced.

Marls.

Shell marls of marine deposit are discovered in nearly all parts of the State. These generally are of some value as fertilizers, but far inferior to the phosphates. The deposits of marls are often in vast beds and of greatly varied state of disintegration. Some are very fine and compact; others coarse and loose. The marls have their adaptation wherever the soils are in want of alkalies, as lime and potash. It is, in the main, better adapted to sandy than to clay soils, and the orange tree and others of the citrus tribe are generally benefited by its liberal supply.

Lime.

No more important article for building purposes, the various industrial arts and agriculture than lime, could, perhaps, be named; and it is fortunate for Florida that no longer will the main dependence be on importation. Still it is true that a large proportion of the limestone of this State is not capable of producing good lime. The rock is generally too silicious and however well burnt will slack poorly.

It is remarkable how constantly silica either in form of sand grains, or in compact and chemical combination, is present in the lime rocks of the Gulf coast. The grades run from nothing to an hundred per cent., that is, from limestone free from silica to the state of pure flint, without the trace of lime present. But the latter case is rare. On the other hand, also, a lime rock entirely free from silica, is equally rare. In respect to the presence of silicious matter in limestone the casual observer is ever liable to be deceived. On first sight, most of the lime rock of Florida is supposed to be capable of forming good lime, while the facts are the reverse. Still, as stated, there is good lime material in many parts of the State, and some of excellent character, as is proven by results of an analysis by J. M. Pickel, Prof. of Chemistry in the State Agricultural College, which afforded 93.67 of carbonate of lime, being equivalent to 52.46 per cent. of quick lime.

CLAYS.

What has been stated of the variety in the lime rock of the State, may well be remarked also of the clay. It is almost infinitely variable in regard to the presence of silica and lime, yet there is no inconsiderable good clay in the State, for most of the clay industries and uses. The best clay that I have yet found, that is the largest deposit of the best clay, is in Escambia county, six miles east of Pensacola, on the line of P. & A. R. R. But I have visited no county as yet in which I have not found clay that will make passably good brick, when properly handled. The presence of much lime and an excess of sand is the great drawback however. The former will cause the clay to "run" in burning, while the latter causes the brick to be soft or disposed to crumble.

I have found a stratum of kaolin of a pretty white appearance, and at greatly variable depth of deposit, as from a very thin layer to a depth of several feet, to be often met with in divers parts of the State. I need not name the localities, as they are very numerous. But here is a great liability for a casual observer, or in some cases even an expert, to be deceived. There are quite a variety of fine white deposits which are greatly alike in appearance. A very common white deposit is found which consists of an exceedingly fine silt or powder of marine shells. Again, white clay may have lime material of almost exactly like appearance, most intimately commingled, and in all proportions. Magnesia is occasionally found in fine powder, and is sometimes, though less commonly, present in white clay.

A beautiful *black* clay of great fineness, and another *red* of like texture; and still others of mixed colors—often mottled of red, white and purple or black colors, of great delicacy—(" *calico-clays* ") are found at the Kehoe brick yards, east of Pensacola. Similar " calico-clays " are to be seen in lower beds of clay deposits all over Florida and adjoining States, but nowhere have I found it as fine as at the above named localities. I may remark that the black clay burns red while the red is whitened in burning. Clays sufficiently fine and pure for pottery are to be seen at various points, in lower strata, where coarser varieties are seen. Such I have found in most of the counties I have visited. But in many instances I have found it in but small deposits.

I must confess, withal, that I have found the clays suited for the *best* brick, in comparatively rare instances, in sufficient quantity for extensive works.

IRON.

Deposits of iron exist in many localities of Florida, but the *quantity* thereof is yet a problem. It is out of the question that the brief inspection of localities, alone possible in the work now undertaken, should determine a question which requires much labor in excavating or drilling, for a solution. Whether therefore iron exists in paying quantities it is yet to be determined. But a locality in Jackson county lately visited has seemingly a rather extensive deposit. Indeed, several places in this county are probably alike full of promise of practical results.

The iron of Florida, so far as known to me, is of the limonite variety. It is not the best iron ore. It is the kind often called the kidney ore. But when this is of good grade it is still an ore of great value in localities where the better classes of iron ore are absent, and I am gratified that Florida may not be entirely overshadowed by the wonderful deposit possessed by our next neighbor.

One of the most notable physical facts of our State is the universality of the presence of iron in *some* form and combination. Nearly all our clays are more or less stained by oxyds of iron, from the lightest yellow to the deepest red, brown and black. A large proportion of the running water of wells and springs are of the chalybeate character; in springs and wells these are commonly called *sulphur waters*, because of the presence of sulphurated hydrogen occasioned by chemical action. The clays are greatly liable to be full of nodules and grains, composed of this metal, combined with sand and clay. All these nodules and grains are of a peroxyd of iron, with the associated other materials.

COAL.

The presence of coal in the deposits of our State has long been a problem, and perhaps no other question has been so frequently put during the brief time of the present work, as this: "have you found coal?" It has been very desirable, therefore, that a solution to this might be soon brought about, and at length it has come. Coal is present. Of course it can only be expected to be of the soft brown or lignite variety. None other would probably exist in any tertiary deposit.

In the very last excursion made before the going to the printer of this first report, I found a vein of coal in Santa Rosa county, located at a distance of less than one mile north of Milton and near the west bank of the Blackwater river. The entire thickness of this vein is about 30 inches, but the upper surface is percolated by clay to some extent, which damages it somewhat.

But for the fact that most persons would expect to find coal to appear in cubic forms or at least somewhat solid, it is very certain that this deposit would have been discovered earlier by the citizens, who doubtless have noticed the black belt extending all along either side of a deep recent excavation of some considerable extent into the bluff. The texture of tertiary coal was not known, doubtless, and so the problem of coal in Florida escaped solution for a longer time than would else have been the case. No one would have supposed that the heavy trains on one of the Pacific R. R. were propelled over the Rocky Mountains with just such a coal as this.

But the discovery above has as yet alone been *made*. No one knows how much coal there is in this deposit nor whether there are other deposits. Nevertheless we may indulge a fair prospect. The coal is found, and as tertiary coal exists in various other localities, and in no inconsiderable quantity: it may be so here in Florida. The outcrop of this deposit, along both margins of this gulch, is 10 to 12 rods, and the vein is horizontal. It probably extends to a considerable distance and breadth. The depth of the vein below the common surface is only about 8 feet. It lies high above water level of the river.

Doubtless other deposits of coal will now be found.

BUILDING STONE.

A great many inquiries from contractors and others have been made of me since the work began, to know whether a substantial building stone has been found. No answers entirely satisfactory have yet been afforded, and yet there are rock materials for building purposes in various parts of the State.

In Wakulla county there is a limestone of some consistence and durability. This admits of dressing and doubtless will be of value. In Jackson county an abundance of an arenaceous limestone reposes near the crests of the hills on either side of the Chipola river, which has been for years taken from the quarries by sawing, which is easily effected because of the softness of the material while reposing in the beds. This rock is of a porous texture and is liable to imbibe moisture; but what may appear singular the rock is respectably durable, as is evidenced by the structures in Marianna, the capital of the county. The walls of the old Union Bank building and some others were built entirely of this rock some forty years ago, and are now in good state of preservation. A large proportion of the chimneys, habitually constructed on the exterior of houses, are made of this material, and I am informed that a chimney has never been known to fall by disintegration or cracking, though in use many years.

I observed in Marianna the chimneys of a large house, consumed by fire, that now stand firm as monuments of the power of resistance this rock has against the effects of a moderate heat. Still, it is to be observed that as the cementing principle of the sand material of this rock is carbonate of lime, this rock is not a proper material for fire-places and furnaces. The rock is very easily dressed with saw and hammer and is susceptible of easy carving. But sculptures thereof can only be expected to be durable in unexposed situations.

This same kind of rock was noted by me to exist in Hernando county. It is there used in Brooksville for the same purposes as in Jackson county.

A flint rock, though generally fragmental and ill-shaped for ready use for building purposes, appears somewhat abundantly along the lines of the railroads in Suwannee, Alachua, Marion, Sumter and Hernando counties. This rock was evidently deposited from solution by presence of lime and potash, with the silica in the waters of the later